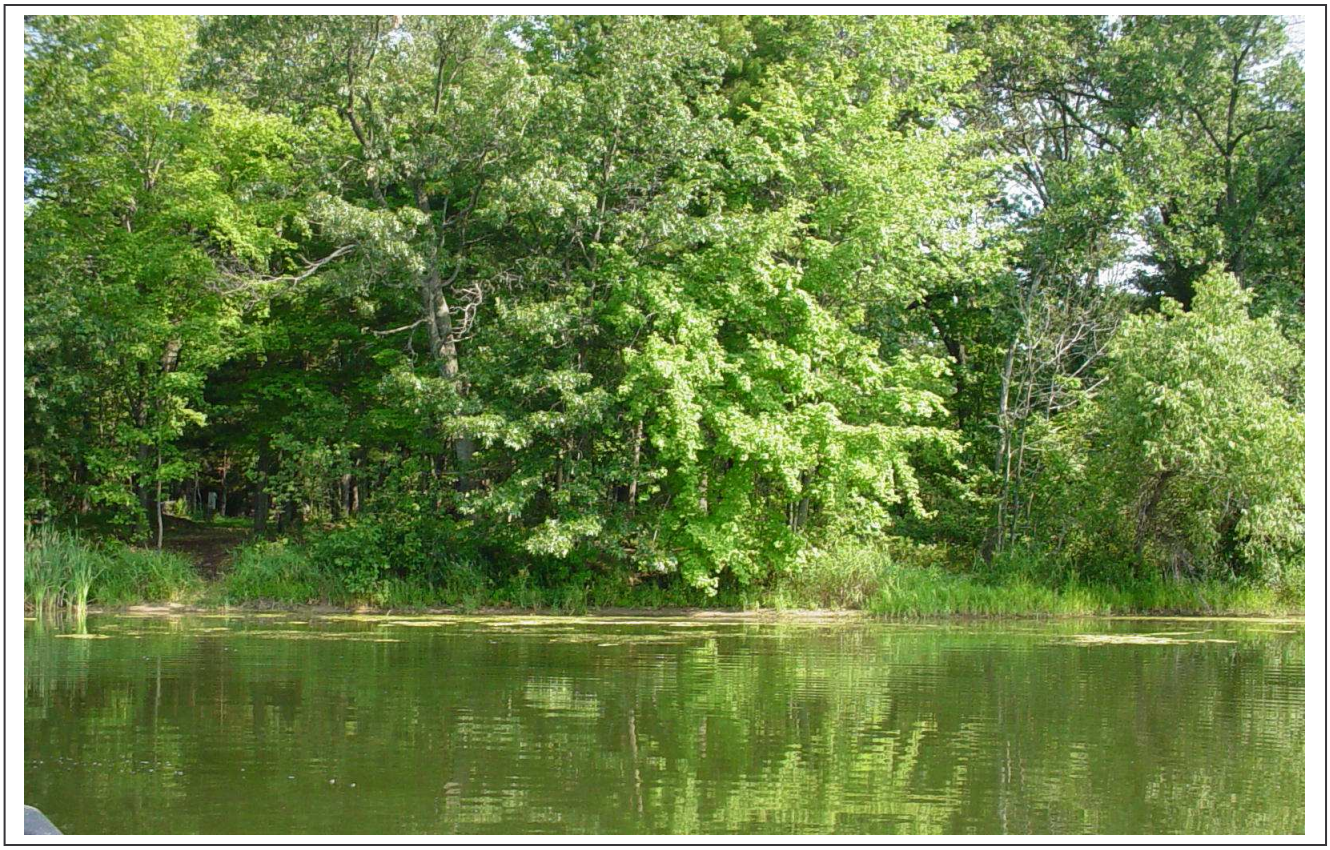

THE AQUATIC PLANT COMMUNITY IN FAWN LAKE, ADAMS COUNTY, WISCONSIN NOVEMBER 2006

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THE AQUATIC PLANT COMMUNITY FOR FAWN LAKE
ADAMS COUNTY 2006

I. INTRODUCTION

An aquatic macrophyte (plant) field study on Fawn Lake was conducted during August 2006 by a staff member the Adams County Land and Water Conservatism Department.

Information about the diversity, density and distribution of aquatic plants is an essential component in understanding the lake ecosystem due to the integral ecological role of aquatic vegetation in the lake and the ability of vegetation to impact water quality (Dennison et al, 1993). This study will provide information useful for effective management of Fawn Lake, including fish habitat improvement, protection of sensitive areas, aquatic plant management, and water resource regulation. This baseline data will provide information that can be used for comparison to future information and offer insight into changes in the lake.

Ecological Role: Lake plant life is the beginning of the lake's food chain, the foundation for all other lake life. Aquatic plants and algae provide food and oxygen for fish and wildlife, as well as cover and food for the invertebrates that many aquatic organisms depend on. Plants provide habitat and protective cover for aquatic animals. They also improve water quality, protect shorelines and lake bottoms, add to the aesthetic quality of the lake, and impact recreation.

Characterization of Water Quality: Aquatic plants can serve as indicators of water quality because of their sensitivity to water quality parameters such as clarity and nutrient levels (Dennison et al, 1993).

Background and History: Fawn Lake is located in the Town of Dell Prairie, Adams County, Wisconsin. The impoundment is 20 surface acres in size. Maximum depth is 13', with an average depth of 5'. During the summer of 2006 when this aquatic plant survey was conducted, the lake was at slightly lower level than usual due to drought and very hot weather. The dam was authorized in 1970-71 to impound Trout Creek. There is a public boat ramp located on the east side of the lake owned by The Adams County Parks Department.

Fawn Lake is easily accessible off of State Highway 13. Residential development around the lake is found along most of the lakeshore. The surface watershed is 25.38% residential, 21.6% non-irrigated agriculture, 56.41% woodlands, and 1.52% water. The ground watershed contains 13.48% non-irrigated agriculture, 58.33% woodlands, 22.44% residential, 5.77% water. There are no known endangered or threatened species in or around the lake.

A fish inventory in 1982 found that bluegill were abundant, largemouth bass and pumpkinseed were common, and perch, bullhead and crappie were present., Managing the lake for bass and bluegill was recommended.

Soils directly around Fawn Lake tend to be sands of various slopes. Such soils tend to be excessively-drained, with infiltration of water being rapid to very rapid, and permeability also high. Such soils also usually have a low water-

holding and low organic matter content, thus making them difficult to establish vegetation on. These soils tend to be easily eroded by both water and wind.

Complaints about heavy aquatic plant growth go back as far as 1974. A review at that time found dense growth of *Potamogeton pectinatus* (sago pondweed) and *Potamogeton foliosus* (leafy pondweed). Some *Ceratophyllum demersum* (coontail) was also found.

WDNR staff performed the first quantitative vegetation survey of Fawn Lake was done by WDNR staff in June 2002. Prior assessments for the exotics *Potamogeton crispus* (Curly-Leaf Pondweed) and *Myriophyllum spicatum* (Eurasian watermilfoil) were conducted in 1999 and 2001.

Historically, management of aquatic plant growth has been by chemical treatments starting in 1981. Several different chemicals have been used, with up to half the lake being treated chemically at one time and multiple treatments within a year also occurring. Early treatments targeted all plant species and may have opened areas for invasion and colonization of the two exotic species now in the lake. Chemical applications are listed below:

Year & No.	Diquat (gal)	Aquathol (gal)	AV-70 (gal)	CuS04 (lbs)	2,4-D (lbs)	Weedbar 64 (gal)	Reward (gal)
1981(3)	3.75	14.5	6.5				
1982(3)	4		6.5	11			
1989(2)	3	2.5		15			
1990	5			50			
1991(2)	2	5		75			
1992(2)	3.5	2		20			
1993	2	2.5					
1994(3)				150			
1995(3)	5			100			

1996(3)	3			100			
1999					270 lbs		
2001					297lbs		
2003					750lbs		
2004						56.75 gal	1 gal
2005		17				56 gal	
totals	31.25	43.5	13	521	1317	112.75	1
	gal	gal	gal	lbs	lbs	gal	gal

Aquathol is a broad-spectrum chemical that kill all aquatic plant species. It has been used in Fawn Lake to target a large aquatic plant growth and *Elodea canadensis.* The other chemicals were used to deal with Curly-Lead Pondweed and Eurasian Watermilfoil. Information about any 2006 applications is not yet available.

In 2002, the residents of the area formed the Fawn Lake District for carrying out programs to improve the lake. The Lake District completed a lake management plan in 2004 that was later approved by the WDNR.

II. METHODS

Field Methods

The study was based on the rake-sampling method developed by Jessen and Lound (1962), using stratified random transects. The shoreline was divided into 12 equal sections, with one transect placed randomly within each segment, perpendicular to the shoreline.

One sampling site was randomly chosen in each depth zone (0-1.5’; 1.5’-5’; 5’-10’; 10’-20’) along each transect. Using long-handled, steel thatching rakes, four rake samples were taken at each site. Samples were taken from each

quarter around the boat. Aquatic species present on each rake were recorded and given a density rating of 0-5.

A rating of 1 indicates the species was present on 1 rake sample.

A rating of 2 indicates the species was present on 2 rake samples.

A rating of 3 indicates the species was present on 3 rake samples.

A rating of 4 indicates the species was present on 4 rake samples.

A rating of 5 indicates that the species was abundantly present on all rake samples.

A visual inspection and periodic samples were taken between transects to record the presence of any species that didn't occur at the raking sites. Gleason and Cronquist (1991) nomenclature was used in recording plants found.

Shoreline type was also recorded at each transect. Visual inspection was made of 50' to the right and left of the boat along the shoreline, 35' back from the shore (so total view was 100' x 35'). Percent of land use within this rectangle was visually estimated and recorded.

Data Analysis:

The percent frequency (number of sampling sites at which it occurred/total number of sampling sites) of each species was calculated. Relative frequency (number of species occurrences/total all species occurrences) was also determined. The mean density (sum of species' density rating/number of sampling sites) was calculated for each species. Relative density (sum of species' density/total plant density) was also determined. Mean density where present (sum of species' density rating/number of sampling sites at which

species occurred) was calculated. Relative frequency and relative density results were summed to obtain a dominance value. Species diversity was measured by Simpson's Diversity Index.

The Average Coefficient of Conservatism and Floristic Quality Index were calculated as outlined by Nichols (1998) to measure plant community disturbance. A coefficient of Conservatism is an assigned value between 0 and 10 that measures the probability that the species will occur in an undisturbed habitat. The Average Coefficient of Conservatism is the mean of the coefficients for the species found in the lake. The coefficient of conservatism is used to calculate the Floristic Quality Index, a measure of a plant community's closeness to an undisturbed condition.

An Aquatic Macrophyte Index was determined using the method developed by Nichols et al (2000). This measurement looks at the following seven parameters and assigns each of them a number on a scale of 1-10: maximum depth of plant growth; percentage of littoral zone vegetated; Simpson's diversity index; relative frequency of submersed species; relative frequency of sensitive species; taxa number; and relative frequency of exotic species. The average total for the North Central Hardwoods lakes and impoundments is between 48 and 57.

III. RESULTS

Physical Data

The aquatic plant community can be impacted by several physical parameters. Water quality, including nutrients, algae and clarity, influence the plant

community; the plant community in turn can modify these criteria. Lake morphology, sediment composition and shoreline use also affect the plant community.

The trophic state of a lake is a classification of water quality (see Table 1). Phosphorus concentration, chlorophyll a concentration and water clarity data are collected and combined to determine a trophic state. **Eutrophic lakes** are very productive, with high nutrient levels and large biomass presence. **Oligotrophic lakes** are those low in nutrients with limited plant growth and small fisheries. **Mesotrophic lakes** are those in between, i.e., those which have increased production over oligotrophic lakes, but less than eutrophic lakes; those with more biomass than oligotrophic lakes, but less than eutrophic lakes; those with a good and more varied fishery than either the eutrophic or oligotrophic lakes.

The limiting factor in most Wisconsin lakes, including Fawn Lake, is phosphorus. Measuring the phosphorus in a lake system thus provides an indication of the nutrient level in a lake. Increased phosphorus in a lake will feed algal blooms and also may cause excess plant growth. **The 2004-2006 summer average phosphorus concentration in Fawn Lake was 29.97 ug/l.** This is below the average for impoundments. This concentration suggests that Fawn Lake is likely to have some nuisance algal blooms, but not as frequently as many impoundments. This places Fawn Lake in the "good" water quality category for impoundments in the "mesotrophic" level for phosphorus.

Chlorophyll concentrations provide a measurement of the amount of algae in a lake's water. Algae are natural and essential in lakes, but high algal

populations can increase water turbidity and reduce light available for plant growth. **The 2004-2006 summer average chlorophyll concentration in Fawn Lake was 9.23 ug/l.** This places Fawn Lake at the "mesotrophic" level for chlorophyll a results.

Water clarity is a critical factor for plants. If plants receive less than 2% of the surface illumination, they won't survive. Water clarity can be reduced by turbidity (suspended materials such as algae and silt) and dissolved organic chemicals that color or cloud the water. Water clarity is measured with a Secchi disk. **Average summer Secchi disk clarity in Fawn Lake in 2004-2006 was 4.68'.** This is poor to fair clarity, putting Fawn Lake into the "mesotrophic" to "eutrophic" category for water clarity.

It is normal for all of these values to fluctuate during a growing season. They can be affected by human use of the lake, by summer temperature variations, by algae growth & turbidity, and by rain or wind events. Phosphorus tends to rise in early summer, than decline as late summer and fall progress. Chlorophyll a tends to rise in level as the water warms, then decline as autumn cools the water. Water clarity also tends to decrease as summer progresses, probably due to algae growth, then increase as fall approaches.

Table 1: Trophic States

Trophic State	Quality Index	Phosphorus (ug/l)	Chlorophyll a (ug/l)	Sechhi Disk (ft)
Oligotrophic	Excellent	<1	<1	>19
	Very Good	1 to 10	1 to 5	8 to 19
Mesotrophic	Good	**10 to 30**	**5 to 10**	6 to 8
	Fair	30 to 50	10 to 15	**5 to 6**
Eutrophic	Poor	50 to 150	15 to 30	3 to 4
Fawn Lake		**29.97**	**9.23**	**4.68'**

According to these results, Fawn Lake scores as **"mesotrophic"** in its phosphorus, chlorophyll a readings, and Secchi disk readings. With such phosphorus readings and chlorophyll a readings, abundant plant growth and occasional algal blooms would be expected, but the lake has "fair" water clarity.

Fawn Lake readings for hardness and pH score its water as "hard" to "very hard", with the pH running between 6.5 and 8.5. Such lakes tend to produce more fish and aquatic plants than soft water lakes.

Lake morphology is an important factor in distribution of lake plants. Duarte & Kalff (1986) determined that the slope of a littoral zone could explain 72% of the observed variability in the growth of submerged plants. Gentle slopes support higher plant growth than steep slopes (Engel 1985).

Fawn Lake is a narrow, shallow lake fed by a small stream system. Most of the lake is shallow, although there are a couple of areas of steeper slopes within the

lake near the dam. Although fair water clarity can sometimes impede growth because some sunlight is blocked, the shallow depths in Fawn Lake favor plant growth, since the sun can get to most of the sediment to stimulate plant growth.

Sediment composition can also affect plant growth, especially those rooted. The richness or sterility and texture of the sediment will determine the type and abundance of macrophyte species that can survive in a particular lake.

Table 2: Sediment Composition—Fawn Lake

Sediment	**Type**	**0-1.5'**	**1.5'-5'**	**5'-10'**	**10'-20'**	**All Sites**
Hard	Sand	9.09%	22.23%	40.00%	100.00%	18.52%
Mixed	Sand/Silt	9.09%	11.11%			14.81%
Soft	Muck	54.55%	11.11%			25.93%
	Peat		22.22%	60.00%		18.51%
	Peat/Muck	9.09%	22.22%			11.11%
	Silt	9.09%	11.11%			7.41%
	Silt/Peat	9.09%				3.71%

Over 66% of the sediment in Fawn Lake is soft with natural fertility and significant available water holding capacity. Although sand sediment may limit growth, all sandy sites in Fawn Lake were vegetated. In fact, 92% of the sample sites were vegetated in Fawn Lake, no matter what the sediment.

Shoreline land use often strongly impacts the aquatic plant community and thus the entire aquatic community. Impacts can be caused by increased erosion and sedimentation and higher run-off of nutrients, fertilizers and toxins applied to the land. Such impacts occur in both rural and residential settings.

Native herbaceous vegetation was the shoreline cover with highest percent (65.38%) (see Table 3). But disturbed sites, such as those with traditional lawn, rock/riprap, hard structures and pavement, were also frequent, covering over 23% of the shoreline (20.72%). Bare unprotected soil was found (2.31%).

Table 3: Shoreland Land Use—FawnLake

Cover Type		Occurrence frequency at transects	Percent Coverage
Vegetated	Wooded	46.15%	9.62%
Shoreline	Herbaceous	100.00%	65.38%
	Shrubs	23.08%	1.92%
Disturbed	Cultivated Lawn	53.85%	13.46%
Shoreline	Hard Structures	38.46%	3.85%
	Rock/riprap/gravel	15.40%	3.46%
	Bare Soil	15.38%	2.31%

Some type of vegetated shoreline was found at 100% of the sites and covered 76.92% of the lake shoreline.

Macrophyte Data

SPECIES PRESENT

Of the 24 species found in Fawn Lake, 21 were native and 3 were exotic invasives. In the native plant category, 9 were emergent, 3 were free-floating plants, 2 were floating-leaf rooted, and 7 were submergent types (see Table 4). Three exotic invasives, *Myriophyllum spicatum* (Eurasian Watermilfoil), *Phalaris arundinacea* (Reed Canarygrass) and *Potamogeton crispus* (Curly-Leaf Pondweed) were found.

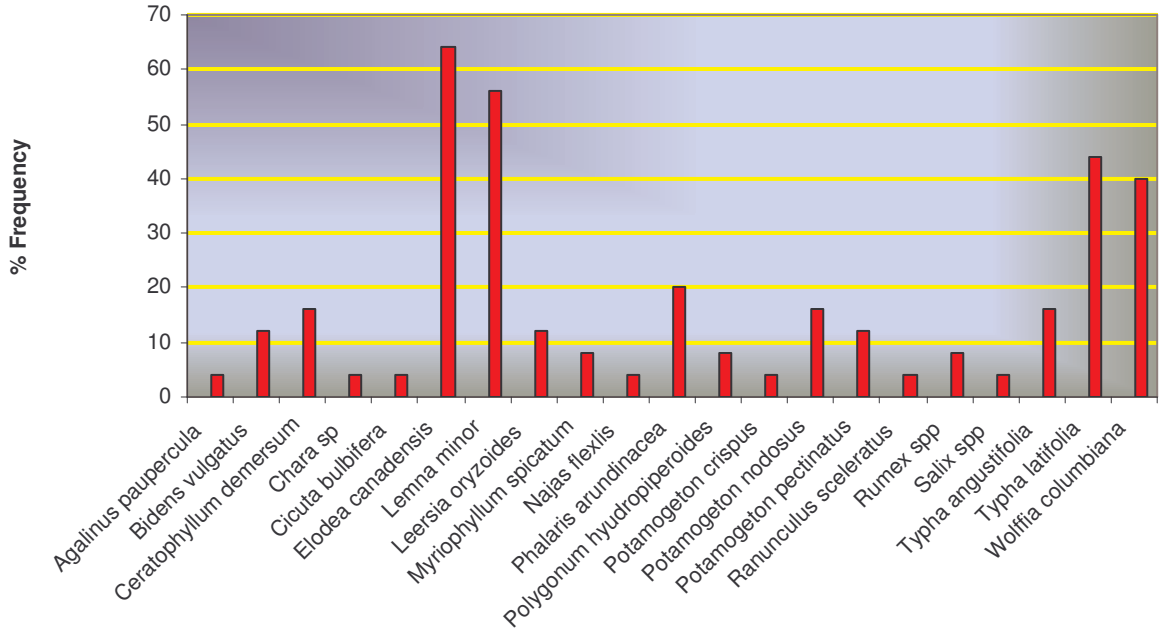
Table 4—Plants Found in Fawn Lake, 2006

Scientific Name	Common Name	Type
Agalinus paupercula	Small-Flowered False Foxglove	Emergent
Bidens vulgatus	Tall Beggar's Tick	Emergent
Ceratophyllum demersum	Coontail	Submergent
Chara sp	Muskgrass	Submergent
Cicuta bulbifera	Water Hemlock	Emergent
Eleocharis acicularis	Needle Spike-Rush	Emergent
Elodea canadensis	Common Waterweed	Submergent
Lemna minor	Small Duckweed	Floating
Leersia oryzoides	Rice Cut-Grass	Emergent
Myriophyllum spicatum	Eurasian Watermilfoil	Submergent
Najas flexlis	Bushy Pondweed	Submergent
Nymphaea odorata	White Water Lily	Floating-Leaf
Phalaris arundinacea	Reed Canarygrass	Emergent
Polygonum hyudropiperoides	Waterpepper	Floating-Leaf
Potamogeton crispus	Curly-Leaf Pondweed	Submergent
Potamogeton nodosus	Long-Leaf Pondweed	Submergent
Potamogeton pectinatus	Sage Pondweed	Submergent
Ranunculus sceleratus	Cursed Crowfoot	Submergent
Rumex spp	Water Dock	Emergent
Salix spp	Willow spp	Emergent
Spirodela polyrhiza	Greater Duckweed	Floating
Typha angustifolia	Narrow-Leaf Cattail	Emergent
Typha latifolia	Wide-Leaf Cattail	Emergent
Wolffia columbiana	Common Watermeal	Floating

FREQUENCY OF OCCURRENCE

Elodea canadensis was the most frequently-occurring plant in Fawn Lake in 2006 (64.00% frequency), followed by *Lemna minor* (56.00%). No other species reached a frequency of 50% or greater.

Chart 1: Occurrence Frequency

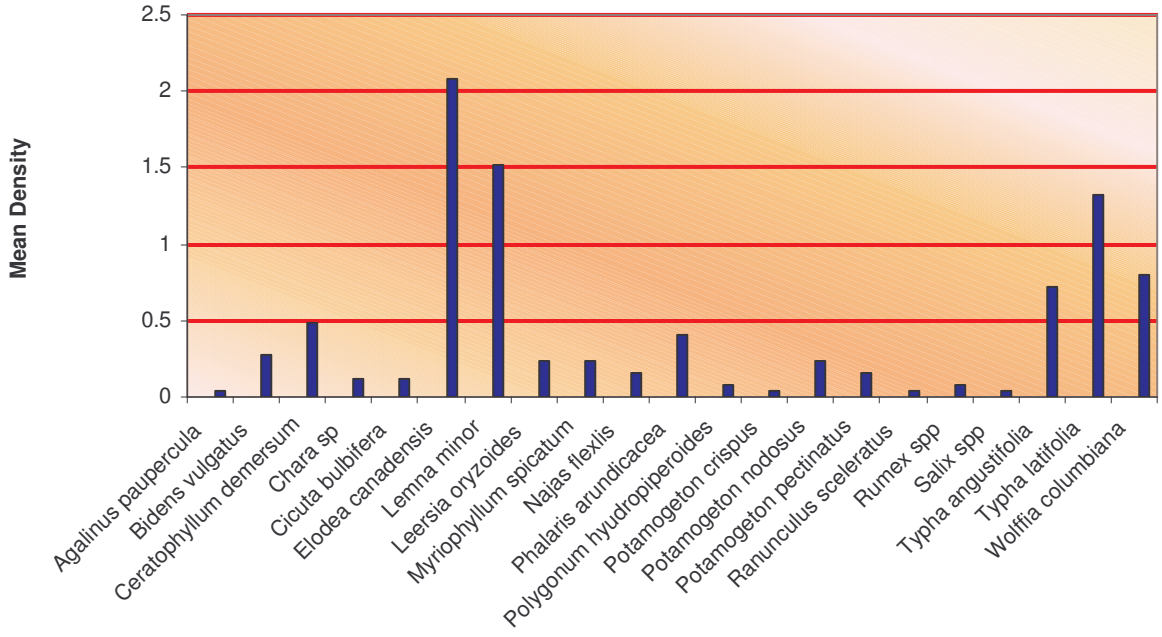


Filamentous algae were found at 92% of the sample sites.

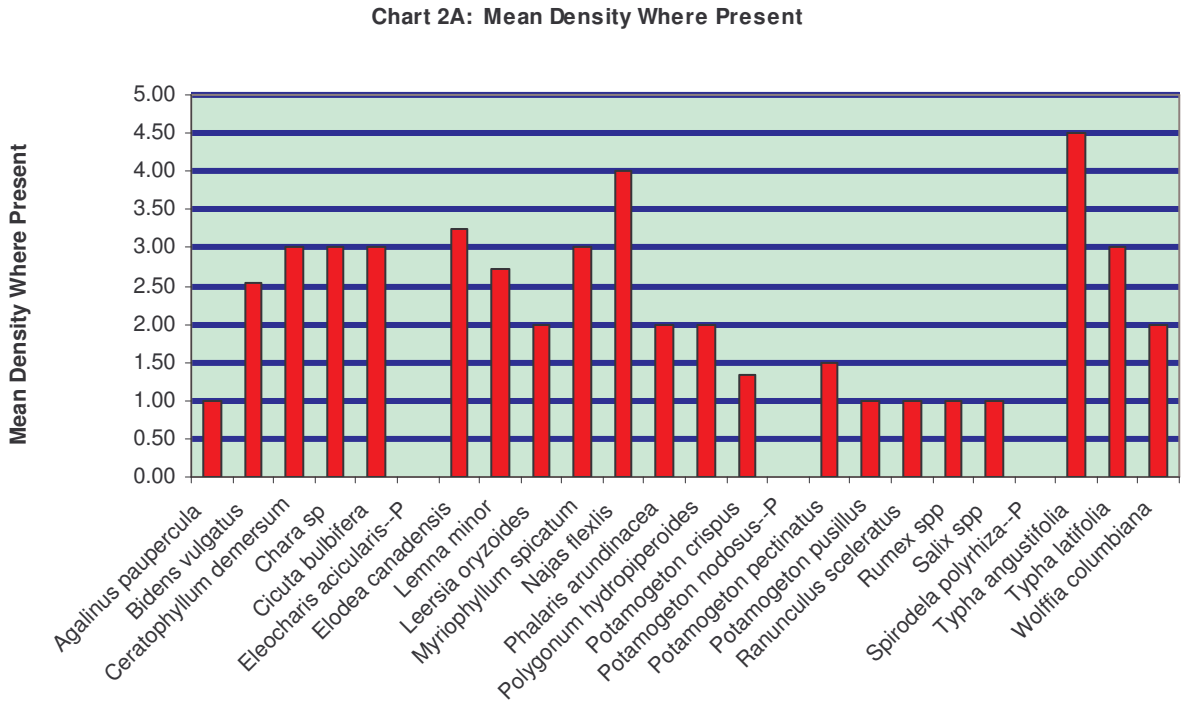
DENSITY OF OCCURRENCE

Elodea canadensis was the densest plant in Fawn Lake, with a mean density of 2.08. Slightly less dense species included *Lemna minor* (1.52) and *Typha latifolia* (1.32). Only *Elodea canadensis* had a mean density over 2.0, meaning only that plant grew at more than average density in the lake overall. *Lemna minor* (2.31) and *Typha latifolia* (2.54) occurred at more than average density in Depth Zone 1 (0-1.5'). Only *Elodea canadensis* (2.25) occurred at more than average density in Depth Zone 2 (1.5'-5'). In Depth Zone 3 (5'-10'), *Elodea canadensis* (2.25) again occurred at more than average density.

Chart 2: Occurrence Density



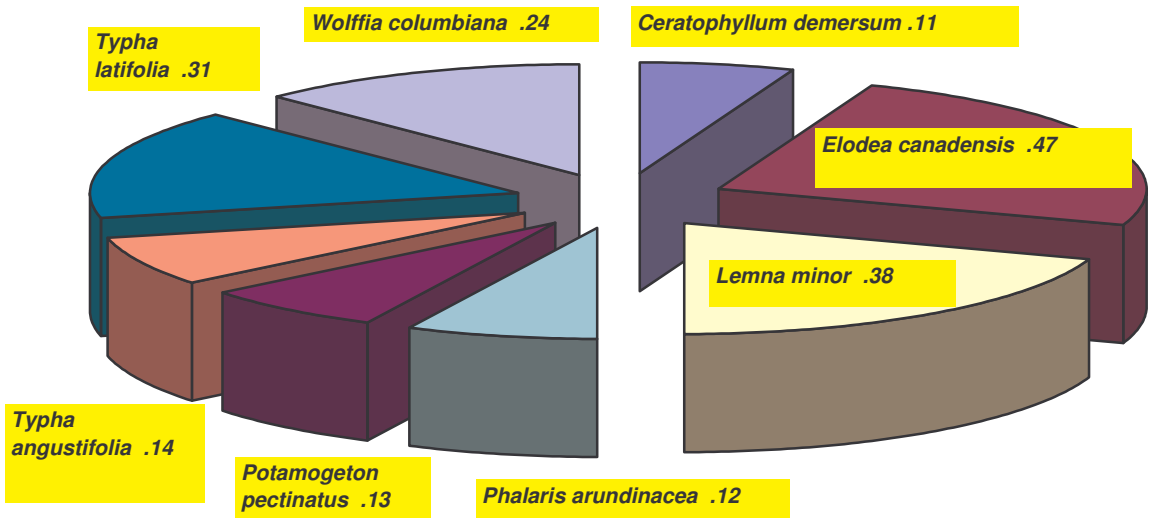
Density figures are higher when the data is evaluated on the basis of "mean density where present." Many more plants are found at higher than average densities at the sites where they are present: *Bidens vulgaris; Ceratophyllum demersum; Chara spp; Cicuta bulbifera; Elodea canadensis; Lemna minor; Myriophyllum spicatum; Najas flexilis; Typha angustifolia; Typha latifolia.* Although there are unvegetated sites on Fawn Lake, the sites that do have aquatic vegetation tend to have dense beds of several kinds of aquatic plants.



DOMINANCE

Relative frequency and relative density are combined into a dominance value that demonstrates how dominant a species is within its aquatic plant community. Based on dominance values, *Elodea canadensis* was the dominant aquatic plant species in Fawn Lake. Sub-dominant were *Lemna minor* and *Typha latifolia. Myriophyllum spicatum, Potamogeton crispus* and *Phalaris arundinacea*, the exotics found Fawn Lake, were not present in high frequency, high density or high dominance. It is possible that *Potamogeton crispus* was under-represented in these calculations, since this survey was performed in August, somewhat later than its peak season.

Chart 3: Dominance



Lemna minor and *Typha latifolia* were dominant in the 0-1.5' depth zone, with *Elodea canadensis* sub-dominant. *Elodea canadensis* dominated the 1.5'-5' depth zone, with *Lemna* minor and *Wolffia columbiana* sub-dominant. *Wolffia columbiana* was dominant in 5'-10' depths; *Elodea canadensis* and *Lemna minor* were sub-dominant.

DISTRIBUTION

Aquatic plants occurred at 92% of the sample sites in Fawn Lake to a maximum rooting depth of 8'. Free-floating plants were found three depth zones (see Appendix B); no aquatic plants were found in depths over 10'.

Secchi disc readings are used to predict maximum rooting depth for plants in a lake (Dunst, 1982). Based on the summer 2004-2006 Secchi disc readings, the predicted maximum rooting depth in Fawn Lake would be **8.44 feet.** During the 2006 aquatic plant survey, rooted plants were found at a depth of **8'**, i.e., rooted plants were at a depth similar to that to be expected by Dunst calculations.

The 0-1.5' depth zone (Zone 1) produced the most occurrence of plant growth. There was a sharp drop in occurrence in Zone 2 (1.5'-5'), then another drop to Zone 3 (5'-10'). No aquatic plants were found in Zone 4 (over 10'), although filamentous algae were found. The same order was followed with aquatic plant density.

Chart 4: Zone Frequency

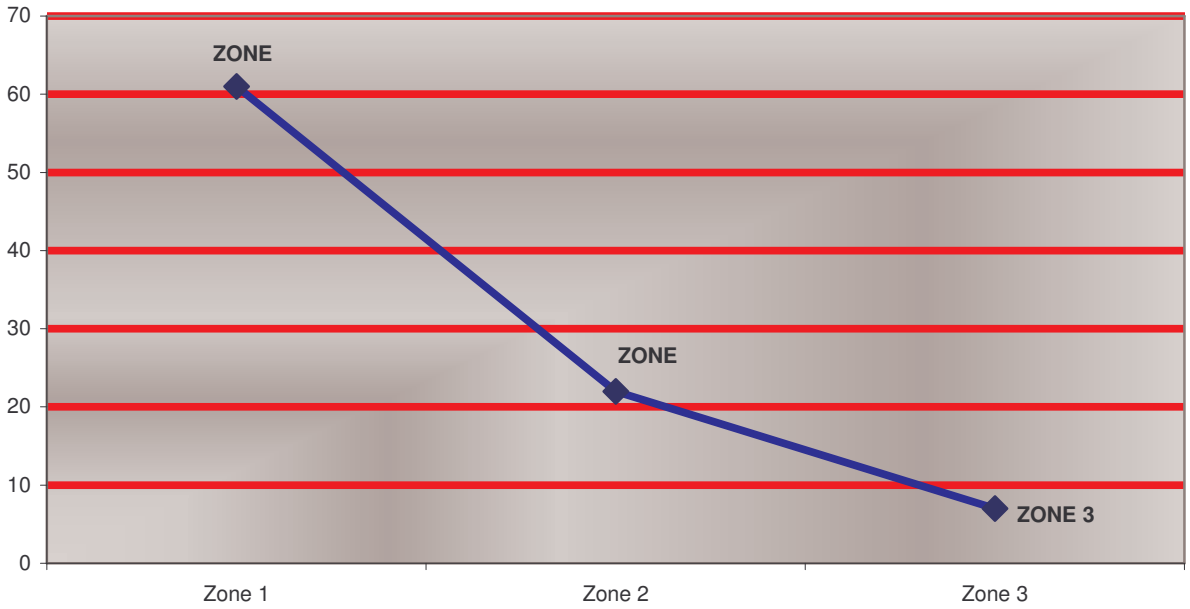
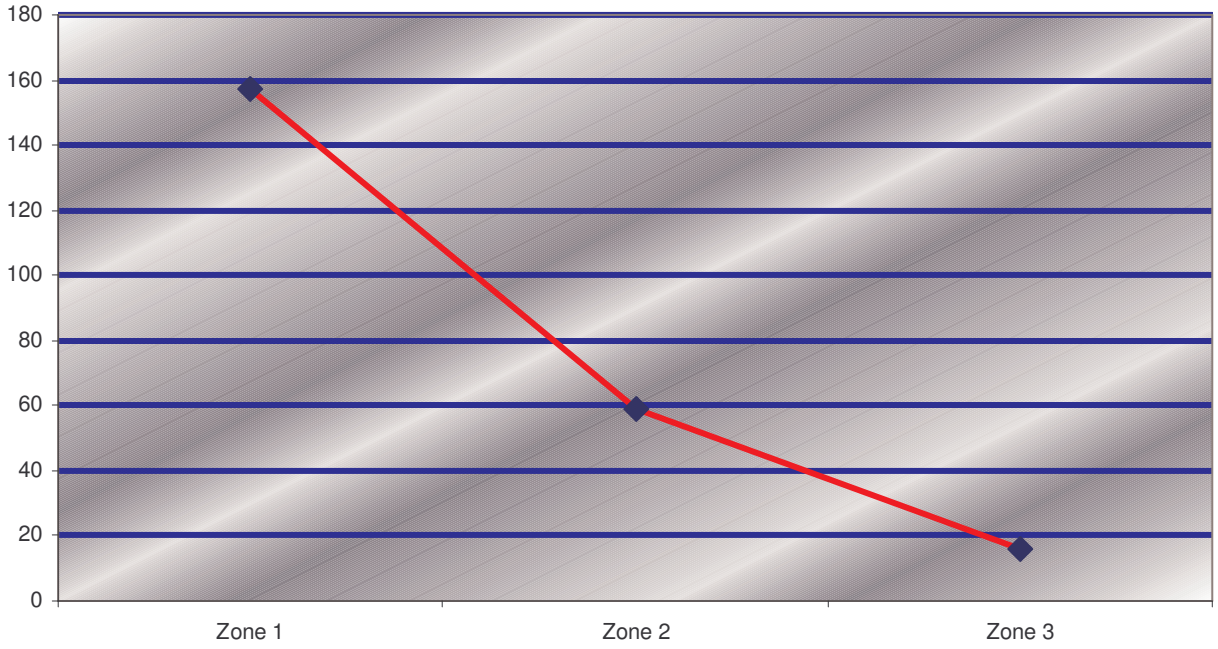


Chart 5: Zone Density



The greatest number of species per site (species richness) was found in Zone 1 with 4.69 species richness. A sharp drop was found in Zone 2 and Zone 3, with species richness of 2.75 and 1.75 respectively. Overall species richness was 3.96.

THE COMMUNITY

The Simpson's Diversity Index for Fawn Lake was .81, suggesting poor species diversity. A rating of 1.0 would mean that each plant in the lake was a different species (the most diversity achievable). This places it in the lowest quartile for Simpson's Diversity Index readings for both North Central Hardwood Forest and for all Wisconsin Lakes. The Aquatic Macrophyte Community Index for

Fawn Lake is 40. This is in lowest quartile for North Central Wisconsin Hardwood Lakes and all Wisconsin lakes.

Table 5: Aquatic Macrophyte Community Index

Aquatic Macrophyte Community Index for Fawn Lake 2006		
Category	Fawn Lake results	Value
Maximum rooting depth	8'	3
% littoral area vegetated	92%	10
%submersed plants	69%	8
% sensitive plants	0%	1
# taxa found	21 (3 exotic)	9
exotic species frequency	16%	4
Simpon's Diversity	.81	5
total		**40**

The presence of several invasive, exotic species could be a significant factor in the future. Currently, none of the exotic species appear to be taking over the aquatic plant community, perhaps due to the high density and occurrence of other native plants such as *Elodea canadensis.* *Myriophyllum spicatum* should be monitored, since its tenacity and ability to spread to large areas fairly quickly could make it a danger to the diversity of Fawn Lake's already limited aquatic plant community.

A Coefficient of Conservatism and a Floristic Index calculation were performed on the field results. The average Coefficient of Conservatism measures the community's sensitivity to disturbance, while the Floristic Index measures the community's closeness to an undisturbed condition. Indirectly, they measure past and/or current disturbance to the particular community.

Previously, a value was assigned to all plants known in Wisconsin to categorize their probability of occurring in an undisturbed habitat. This value is called the plant's Coefficient of Conservatism. A score of 0 indicates a native or alien opportunistic invasive plant. Plants with a value of 1 to 3 are widespread native plants. Values of 4 to 6 describe native plants found most commonly in early successional ecosystem. Plants scoring 6 to 8 are native plants found in stable climax conditions. Finally, plants with a value of 9 or 10 are native plants found in areas of high quality and are often endangered or threatened. In other words, the lower the numerical value a plant has, the more likely it is to be found in disturbed areas.

The Average Coefficient of Conservatism for Fawn Lake was 4.09. This puts it in the lowest average quartile for Wisconsin Lakes (6.0) and for lakes in the North Central Hardwood Region (5.6). The aquatic plant community in Fawn Lake is in the category of those most tolerant of disturbance, probably due to selection by a series of past disturbances.

The Floristic Quality Index of the aquatic plant community in Fawn Lake of 18.77 is in the lowest quartile for Wisconsin Lakes (22.2) and the North Central Hardwood Region (20.9). This indicates that the plant community in Fawn Lake is within the group of lakes farthest from an undisturbed condition in Wisconsin overall and in the North Central Hardwood Region. In other words, the aquatic plant community in Fawn Lake has impacted by a high amount of disturbance.

"Disturbance" is a term that covers many disruptions to a natural community. It includes physical disturbances to plant beds such as boat traffic, plant

harvesting, chemical treatments, dock and other structure placements, shoreline development, erosion and fluctuating water levels. Indirect disturbances like sedimentation, erosion, increased algal growth, and other water quality impacts will also negatively affect an aquatic plant community. Biological disturbances such as the introduction of non-native and/or invasive species (such as the Eurasian Watermilfoil, Reed Canarygrass and Curly-Leaf Pondweed found here), destruction of plant beds by fish or wildlife can also negatively impact an aquatic plant community.

A comparison of some criteria at the shores with 100% native vegetation to the shores with disturbance show little variation in the criteria between the two shore types.

	Natural	Disturbed
Number of species	15	20
FQI	12.39	16.55
Average Coef. Of Cons	3.2	3.7
Simpson's Index	0.81	0.81
Filamentous algae	89%	85%

Using these figures, the disturbed shores actually had higher scores for FQI, Average Coefficient of Conservatism, species number and % of filamentous algae. The high amount of disturbance in the lake overall probably explains this lack of differentiation between natural and disturbed shores.

IV. DISCUSSION

Based on water clarity, chlorophyll and phosphorus data, Fawn Lake is a mesotrophic impoundment lake with fair water clarity and good to fair water

quality. This trophic state should support fairly abundant plant growth and frequent algal blooms.

Sufficient nutrients (trophic state), shallow lake, and soft sediments at Fawn Lake favor plant growth. Despite the sometime limiting effect of sand sediments on aquatic plant growth, 92% of the lake is vegetated, suggesting that even the sand sediments in Fawn Lake hold sufficient nutrients to maintain aquatic plant growth.

All recorded aquatic plant treatments in Fawn Lake have been chemical. There is no record of mechanical harvesting to try to reduce plant growth. A regular schedule and pattern of machine harvesting could help in removing vegetation from the lake and may significantly help with nutrient reduction since Fawn Lake is at the top of its watershed. The harvesting should also be designed to set back the growth of Eurasian Watermilfoil and Curly-Leaf Pondweed, not spread them further. It might also help to skim off the high density of filamentous algae and free-floating plants.

The lake does have a mixture of emergent, floating and rooted plants. Of the 24 species found in Fawn Lake, 21 were native and 3 were exotic invasives. Of native plants, 9 were emergent, 3 were free-floating plants, 2 were rooted floating-leaf plants, and 7 were submergent types. Three exotic invasives, *Myriophyllum spicatum* (Eurasian Watermilfoil), *Phalaris arundinacea* (Reed Canarygrass) and *Potamogeton crispus* (Curly-Leaf Pondweed) were found.

Elodea canadensis was the most frequently-occurring plant in Fawn Lake in 2006 (64.00% frequency), followed by *Lemna minor* (56.00%). No other

species reached a frequency of 50% or greater. *Elodea canadensis* was also the densest plant in Fawn Lake, with a mean density of 2.08. Somewhat less dense species were *Lemna minor* (1.52) and *Typha latifolia* (1.32). Only *Elodea canadensis* had a mean density over 2.0, meaning only that plant grew at more than average density in the lake overall. *Lemna minor* (2.31) and *Typha latifolia* (2.54) occurred at more than average density in Depth Zone 1 (0-1.5'). Only *Elodea canadensis* (2.25) occurred at more than average density in Depth Zone 2 (1.5'-5'). In Depth Zone 3 (5'-10'), *Elodea canadensis* (2.25) again occurred at more than average density.

The areas of wooded and wetland shores on the most of the shore of the lake should be preserved as they are important to maintain habitat and to serve as a water quality buffer for the lake. Studies have suggested that runoff from establish wooded land is substantially less than that of developed areas.

The Simpson's Diversity Index for Fawn Lake was .81, suggesting poor species diversity. The Aquatic Macrophyte Community Index (AMCI) Fawn Lake is 40, placing it in the lowest quartile for Wisconsin Lakes and for North Central Wisconsin Hardwood Lakes. The Average Coefficient of Conservatism score puts Fawn Lake in the category of those very tolerant of disturbance. The Floristic Quality Index of the aquatic plant community in Fawn Lake of 18.77 is below average for Wisconsin Lakes and lakes in the North Central Hardwood Region. This indicates that the plant community in Fawn Lake is among the group of lakes farther from an undisturbed condition farther than the average state or regional lake.

Some kind of native vegetation was the dominant shore cover in Fawn Lake (total of 76.97%). However, disturbed sites, such as those with cultivated lawn, hard structure, rock/riprap and pavement, were also common, with coverage of over 20%. Of natural shorelines, herbaceous vegetation—mostly cattails-- had the most coverage (65.38%). Some type of disturbed shoreline was found at 69% of the sites. The disturbed shorelines offer little protection for water quality and have significant potential to negatively impact Fawn Lake's water quality by increased runoff (including lawn fertilizers, pet waste, pesticides) and shore erosion.

An aquatic plant community evaluation was conducted on Fawn Lake in 2001. Comparing the results of the two evaluations, there are some changes in the aquatic plant community. The number of species present increased. The number of submergent plants decreased. Although species richness, Floristic Quality Index and Average Coefficient of Conservatism increased, Simpson's Index of Diversity showed a big drop and the Aquatic Macrophyte Community Index was also down. No Eurasian Watermilfoil was found, probably due to the aquatic plant survey in 2006 occurring after spot chemical treatments. *Potamogeton crispus* frequency decreased, although it is possible that it is underrepresented due to the 2006 survey occurring after the peak season for *Potamogteton cripus.* More long-term information is needed to determine whether the aquatic plant community is responding to the chemical treatments, fluctuating water levels from the recent drought, and increased nutrient loading.

Further, when calculating the coefficient of similarity between the 2001 and 2006 surveys, they score as statistically dissimilar. Based on frequency of occurrence, the aquatic plant communities of the two years are only 46%

similar. Based on relative frequency, they are 41% similar. Similarity percentages of 75% are considered statistically similar; obviously, Fawn Lake percentages are far from that.

Fawn	2001	2006	Change	%Change
Number of Species	15	24	9	60.0%
Maximum Rooting Depth	10.5	8.0	-3	-23.8%
% of Littoral Zone Unvegetated	0	8%	.08	15.4%
%Sites/Emergents	24.64%	56.52%	0.3	120.4%
%Sites/Free-floating	28.21%	69.57%	0.4	146.6%
%Sites/Submergents	100.00%	78.26%	-0.2	-21.7%
%Sites/Floating-leaf	0.00%	21.74%	0.2	100.0%
Simpson's Diversity Index	0.89	0.88	0.09	-9.0%
Species Richness	3.85	3.96	0.11	2.9%
Floristic Quality	13.68	18.77	5.09	37.2%
Average Coefficient of Conservatism	4.33	4.1	0.57	16.1%
AMCI Index	43	40	-3.0	-7.0%

The earliest aquatic plant survey (1974) in Fawn Lake recorded showed an aquatic plant community dominated by native pondweeds and coontial. The survey in 2001 indicated a shift to an aquatic plant community dominated by exotic plants. Some native plants that were found in 2001 were not found in 2006: *Carex spp; Juncus effusus; Myriophyllum sibiricum.* The latter may have been negatively impacted by the chemical applications targeting *Myriophyllum spicatum.* Several plants that are tolerant of disturbance decreased in frequency of occurrence: *Ceratophyllum demersum; Chara spp; Potamogeton pusillus.* However, it seems that their place may have been taken

by another plant tolerant of disturbance: *Elodea canadensis.* This plant now occurs with over 61% frequency, up from 43% just five years ago. *Potamogeton pectinatus*, fairly disturbance-tolerant, also increased in frequency.

Besides the invasives already mentioned, *Phalaris arundinacea* had a decrease in frequency of occurrence by more than one-half. Several native emergents were found in 2006, but not noted in 2001: *Ranunculus sceleratus; Rumex spp; Salix spp. Typha angustifolia* and *Typha latifolia*, both of which have very high tolerance for disturbance. Greatly increased in frequency were the free-floating plants, *Lemna minor* and *Wolffia columbiana*. This may indicate a significant increase in nutrient loading in Fawn Lake.

V. CONCLUSIONS

Fawn Lake is a mesotrophic impoundment with good water quality and fair water clarity. The quality of the aquatic plant community in Fawn Lake is low for Wisconsin lakes and for lakes in the North Central Hardwood region, as measured by Coefficient of Conservatism. Floristic Quality Index, and AMCI, suggesting impacts by above average levels of disturbance. Filamentous algae are abundant. Structurally, the aquatic plant community contains emergent plants, free-floating plants, floating-leaf rooted plants and submergent plants.

When the aquatic plant survey was performed in 2006, 92% of the littoral zone was vegetated. The potential for plant growth at all depths of the lake is present, even though a few of the lake sediments are sandy. This growth

percent is over the recommended vegetation percentage for best fishing (50%-85%).

Elodea canadensis was the most frequently-occurring plant in Fawn Lake in 2006 (64.00% frequency), followed by *Lemna minor* (56.00%). No other species reached a frequency of 50% or greater. *Elodea canadensis* was also the densest plant in Fawn Lake, with a mean density of 2.08. Somewhat less dense plants were *Lemna minor* (1.52) and *Typha* latifolia (1.32). Only *Elodea canadensis* had a mean density over 2.0, meaning only that plant grew at more than average density in the lake overall. *Lemna minor* (2.31) and *Typha* latifolia (2.54) occurred at more than average density in Depth Zone 1 (0-1.5'). Only *Elodea canadensis* (2.25) occurred at more than average density in Depth Zone 2 (1.5'-5'). In Depth Zone 3 (5'-10'), *Elodea canadensis* (2.25) again occurred at more than average density. *Elodea canadensis* was the dominant aquatic plant in Fawn Lake.

A healthy and diverse aquatic plant community plays a vital role within the lake ecosystem. Plants help improve water quality by trapping nutrients, debris and pollutants in the water body; by absorbing and/or breaking down some pollutants; by reducing shore erosion by decreasing wave action and stabilizing shorelines and lake bottoms; and by tying-up nutrients that would otherwise be available for algae blooms. Aquatic plants provide valuable habitat resources for fish and wildlife, often being the base level for the multi-level food chain in the lake ecosystem, and also produce oxygen needed by animals.

Further, a healthy and diverse aquatic plant community can better resist the invasion of species (native and non-native) that might otherwise "take over"

and create a lower quality aquatic plant community. A well-established and diverse plant community of natives can help check the growth of more tolerant (and less desirable) plants that would otherwise crowd out some of the more sensitive species, thus reducing diversity.

Vegetated lake bottoms support larger and more diverse invertebrate populations that in turn support larger and more diverse fish and wildlife populations (Engel, 1985). Also, a mixed stand of aquatic macrophytes (plants) supports 3 to 8 times more invertebrates and fish than do monocultural stands (Engel, 1990). A diverse plant community creates more microhabitats for the preferences of more species.

MANAGEMENT RECOMMENDATIONS

(1) Because the plant cover in the littoral zone of Fawn Lake is over the ideal (25%-85%) coverage for balanced fishery, consideration should be given to reducing plant growth in at least some areas. A map of areas to have plants removed should be developed, then removal should occur by hand in shallow areas to be sure that entire plants are removed and to minimize the amount of disturbance to the settlement.

(2) Natural shoreline restoration in some areas is needed. Disturbed shorelines cover too much of the current shoreline. A buffer area of native plants should be restored in these areas, especially on those sites that now have traditional lawns mowed to the water's edge. Stormwater management of these impervious surfaces is essential to maintain the high quality of the lake water.

(3) No lawn chemicals, especially lawn chemicals with phosphorus, should be used on properties around the lake. If they must be used, they should be used no closer than 50' to the shore.

(4) An aquatic plant management plan should be developed with a regular activity schedule. Such plans will be required by the Wisconsin DNR for aquatic plant permits and grants and will also assist in improving the quality of the native aquatic plant community in Fawn Lake. Mechanical harvesting in deeper areas could significantly reduce level of nutrients in the water.

(5) The plan should consider including target harvesting for Eurasian Watermilfoil (EWM) to prevent further spread.

(6) The Fawn Lake Association may want to apply for grants from the Wisconsin Department of Natural Resources to help defray the cost of aquatic plant management.

(7) Exotic species signs at the boat landing should be maintained.

(8) No broad-scale chemical treatments of aquatic plant growth are recommended due to the undesirable side-effects of such treatments, including increased nutrients from decaying plant material and decreased dissolved oxygen and opening up more areas to the invasion of EWM. Chemical treatments should be used selectively for EWM or CLP only.

(9) Fallen trees should be left at the shoreline.

(10) Although Adams County Land & Water Conservatism Department currently takes regular surface water samples, the program only goes through 2006. Fawn Lake residents should start a monitoring program through the Wisconsin Self-Help Monitoring Program to permit on-going monitoring of the lake trends for basically no cost.

(11)Fawn Lake residents should identify, cooperate with and participate in watershed programs that will reduce nutrient and sediment inputs.

(12)Once critical habitat areas are formally determined, the lake management plan should include recommendations for preserving these areas.

(13) The areas where there is undisturbed wooded shore and wetlands should be maintained and left undisturbed.

(14) The Fawn Lake District should make sure that its lake management plan takes into account all inputs from both the surface and ground watersheds and addresses the concerns of this lake community.

(15) Cooperation with the Adams County Parks Department in keeping the boat ramp in safe condition should help reduce any negative impacts caused by the current poor condition of the ramp and entry to the lake.

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